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ABSTRACT

This trade and industrial curriculum guide for welding is designed for vocational welding programs that provide 960 hours of instruction. The introductory section provides a statement of welding philosophy, objectives, block time schedule, and recommended facilities and equipment. Following the introductory section, ten blocks of instruction are presented: (1) orientation, (2) basic metallurgy, (3) oxy-gas welding, (4) arc welding, (5) metallic inert gas welding, (6) tungsten inert gas welding, (7) fabrication, (8) testing and qualification, (9) specialized processes, and (10) pre-employment. Each block provides a table that lists the units of instruction, informational content of each unit, and skill development activities. In addition, a list of instructional aids is provided for each block. Appended material includes a unit guide example, a list of safety precautions in welding operations, and suggestions for shop management. (LRA)

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V&TECC CURRICULUM GUIDE

Vocational and Technical Education Curriculum Center

VA7913306

INSTRUCTIONAL GUIDE FOR VOCATIONAL WELDING

CE024170

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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FOREWORD

This is another in a series of Trade and Industrial Curriculum guides. It is intended that this Welding Curriculum Guide be used with vocational programs which prepare students to enter the Welding field.

We purposely eliminated the binding of these guides so that they may be punched and placed in notebooks, thus making it possible to remove and replace material as needed.

Thanks are expressed to all the instructors listed on the following page and to Dr. Lester G. Duenk who coordinated the development of this guide.

We anticipate that you will find it useful to supplement the guide with appropriate lesson plans and instruction sheets.

Ben L. Baines
State Supervisor
Trade & Industrial Education
Virginia Department of ducation
Richmond, Virginia 23216

September 1979

PREFACE

This curriculum guide was developed to serve as a state-wide model for Virginia vocational welding programs. The instructor may utilize this curriculum guide in a manner deemed most advantageous to the local teaching situation.

This guide is designed for 960 hours of instruction and was developed by a group of Virginia vocational welding instructors in a workshop held at Virginia Polytechnic Institute and State University.

The instructors participating in the development of this guide were as follows:

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Everett Ellis	Giles County Vocational School Pearisburg, Virginia
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William E. Hudson	Giles County Vocational School Pearisburg, Virginia
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James E. Smith	Wise County Vocational-Technical School Wise, Virginia
Jim Spears	Scott County Vocational Center Gate City, Virginia

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WELDING

Philosophy

We believe that the welding curriculum will provide the student with the technical knowledge and manipulative skills necessary to become self sufficient as well as instill a feeling of pride in being a skilled craftsperson who will be able to perform the varied welding tasks of the trade.

The student will be motivated to higher levels of achievement and develop attitudes which are conducive to good citizenship.

We further believe this training will encourage a desire within the student to enter the world of work as a productive member of society.

Objectives

The overall purpose of this curriculum is to prepare the student for entry-level postiions by fulfilling the following objectives:

1. To develop an understanding of the welding trade; enccurage safe working habits; and provide a skill sufficient to acquire employment;

2. Gain knowledge and skills of the techniques involved in oxyacetylene and gas welding and cutting;

3. Acquire a knowledge of the techniques involved in arc welding;

4. Gain knowledge and skill in the operation of the MIG welding machine and equipment;

5. Gain knowledge and skill in the operation of the TIG welding machine and equipment;

6. Provide a general understanding of specialized welding processes;

7. To develop an understanding of related math, layout, measurement, blueprint reading and assembly which pertains to welding fabrication;

8. To test successfully and qualify students according to current welding practices;

9. To develop proper work habits, work attitudes, and the desire to obtain and hold a job;

10. To develop an appreciation for habitual cleanliness, neatness, and orderliness in work and personal life; and,

11. To develop self-confidence in acquired knowledge and skills of the trade and to instill the necessary qualities to become a responsible citizen.

Block Time Schedule (suggested)

Block	Title	Recommended Hours
1	Orientation	20-30
2	Basic Metallurgy	30-40
3	Oxy-Gas Welding	90-130
4	Arc Welding	350-430
5	Metallic Inert Gas Welding (MIG)	60-100
6	Tungsten Inert Gas Welding (TIG)	60-100
7	Fabrication	100-150
*8	Testing and Qualification	85
**9	Specialized Processes	15-35
10	Pre-employment	15
	Total	960 hours

The individual instructor may vary the order in which the above blocks are taught, depending upon local circumstances, shop facilities and equipment. However, Orientation and Basic Metallurgy should be taught before teaching the other blocks.

*Includes retraining time or additional instruction from block 4. Actual testing process will take approximately ten hours.

**For instructors who do not have specialized equipment, this block will be used for informational purposes.

Related instruction will be given by lecture, demonstration, and the presentation of audio-visual materials, immediately prior to and during application by the trainee. Approximately 60 to 75% of the allocated time will be spent in manipulative skill development

RECOMMENDED FACILITIES AND EQUIPMENT

The normal facility would house twenty students in an area of approximately 4000 square feet. This space would include: the work area, classroom, storage room, tool room, office, and locker rooms to accommodate male and female students.

It is further recommended that portable screens and movable sucker tubes be installed instead of the traditional welding booths. This system will allow greater flexibility in shop use and reduce the loss of valuable shop space. It also will eliminate the need for special lighting fixtures and will provide more adequate illumination levels at the work area.

Ventilation guidelines may be found in Section 8 of the American National Standards Institute (ANSI). Additional information may be obtained in the pamphlet Safety in Welding and Cutting from the American Welding Society, 2501 N.W. 7th Street, Miami, Florida 33125.

Block 1 Title Orientation

Allotted Time for Block 30 hours

Units of Instruction	Informational Content	Skill-Development Activities
I. School and Class	Lecture-Introduce students to information furnished by individual school, stressing all operating policies.	The students will complete all applicable forms
II. Shop and School Safety	Lecture and Demonstration 1. Provide a basic understanding of general safety requirements a. proper grooming b. safety of co-worker (attitude) c. safe use of equipment d. fire safety e. electrical safety f. good housekeeping	
III. Shop Organization	Lecture 1. To acquaint students with rules and regulations concerning all phases of laboratory operations a. clean-up procedure b. supplies and material c. tool storage	Read, sign and retain required shop rules and regulation forms

Block 1 Title Orientation

Allotted Time for Block 30 hours

Units of Instruction	Informational Content	Skill-Development Activities
IV. Purpose of the Course	Lecture 1. To explain the need for welders 2. Incentives a. job opportunities b. working conditions c. job independence d. benefits	Conduct individual research and report to class
V. Description of the Welding Trade	Lecture 1. To familiarize the students with different phases of welding a. oxygen-acetylene b. ARC c. MIG and TIG d. spot welding e. specialized processes	Students discuss and ask questions
VI. Introduction to (VICA) Vocational Industrial Clubs of America	Lecture 1. Building leadership 2. Organization 3. Competition 4. Activities	Student participation in club activities

Instructional Aids For
Block 1

Films (16 mm)

1. Futures in Welding. National Welding Supply Association, 1900 Arch Street, Philadelphia, Pennsylvania 19103.

2. Slips and Falls. C & P Telephone, 703 East Grace Street, Richmond, Virginia 23219.

3. Best Foot Forward. Modern Talking Picture Service, 2000 L Street, S.W., Washing, D.C. 20036.

4. Playing It Safe With Power Tools. Modern Talking Service, 200 L Street, S.W., Washington, D.C. 20036.

5. ABC of Hand Tools. General Motors Corporation, Public Relations Staff Film Library, General Motors Building, Detroit, Michigan 48202.

6. Everyday Courage and Common Sense. Bureau of Teaching Materials, Virginia Department of Education, Richmond, Virginia 23216.

7. Creative Attitudes. General Motors Corporation, Public Relations Staff Film Library, General Motors Building, Detroit, Michigan 48202.

8. Your Job-Good Work Habits. Bureau of Teaching Materials, Virginia State Department of Education, Richmond, Virginia 23216.

9. Skills Build America. General Motors Corporation, Public Relations Staff Film Library, General Motors Building, Detroit, Michigan 48202.

The following materials can be ordered from Vocation Industrial Clubs of America, Inc., 105 N. Virginia Avenue, Falls Church, Virginia 22046.

10. VICA: Going Places. 15 min. Color. Tells the "VICA" story. It answers what VICA is. Films loaned on a rental-fee basis.

11. On the Road With Charles Kuralt. 5 min. Color film footage by CBS News of the National Leadership Conference in San Antonio, Texas. Indicate reservation dates.

Slides

12. Today's Youth-Tommorrow's Future. 9 min. A slide story presentation which describes National VICA activities. 74 color slides with taped narration. Slides, script and tape or slides and script without tape.

Instructional Aids For
Block 1 (continued)

Film Loops

An Introduction to Welding. J. S. Latta Inc., P. O. Box 1276, Huntington, West Virginia 25715.

References

The following materials may be ordered from Vocational Industrial Clubs of America, Inc., 105 N. Virginia Avenue, Falls Church, Virginia 22046.

1. Leadership Handbook. Order No. #72C7.
2. National Program of Work Guidebook. Order No. #72C18.
3. Parliamentary Procedure at a Glance. By O. Garfield Jones. Paperback. Order No. #72C18.
4. Organizing for Involvement. Order No. #74C3.

Block 2 Title Basic Metallurgy of Weldable Metals and Alloys

Allotted Time for Block 30 hours

Units of Instruction	Informational Content	Skill-Development Activities
I. The identification of metals encountered most frequently	Lecture and metal sample comparison 1. Carbon steel a. appearance b. magnet c. spark test d. weight 2. Aluminum (alloy) a. appearance b. magnet test c. weight 3. Stainless steel a. appearance b. magnet test c. spark test d. weight 4. Cast iron a. appearance b. magnet test c. spark test d. weight 5. Copper a. appearance b. magnet test c. weight 6. Brass a. appearance b. magnet test c. weight	Student compares samples of known metals by a. visual inspection b. weight comparison c. magnet test d. height (by feel)

Instructional Aids For
Block 2

Films (16 mm)

1. This is Steel (Manufacturing Steel). Modern Talking Picture Services, Inc., 9 Garfield Place, Cincinnati, Ohio 45202.

2. The New Bethehem Steel. Modern Talking Picture Services, Inc., 2000 L Street, S.W., Washington, D.C. 20036.

3. Oxyacetylene Flame-Master of Metals. U.S. Department of the Interior, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213.

Aids

Identified Metal Samples.

References

1. New Lessons in Arc Welding. Lincoln Electric Co., Coit Road, Cleveland, Ohio 44117.

2. Metals and How to Weld Them. Jefferson, T.B. The James F. Lincoln Arc Welding Foundation, P.O. Box 3035, Cleveland, Ohio 44117.

3. Welding Skills and Practices. Giachino, J.W., William Weeks and E. J. Brune. American Technical Society, 848 E. 58th Street, Chicago, Illinois 60637.

4. Welding Technology. Kennedy, Gower A., Howard W. Sams Co., Inc., 4330 W. 62nd Street, Indianapolis, Indiana 46206.

5. Welding Technology. (2nd ed.) Giachino, J.W., William Weeks and G. S. Johnson American Technical Society, 848 E. 58th Street, Chicago, Illinois 60637.

6. Welding Skills and Practices. Giachino, J.W., William Weeks and E.J. Brune (4th ed.) American Technical Society, 848 E. 58th Street, Chicago, Illinois 60637.

7. Welding Principles and Practices. Sacks, Raymond J., Chas. A. Bennett Publishing Co., 809 W. Detweiller Drive, Peoria, Illinois 61614.

Block 3 Title Oxy-Gas Welding and Cutting

Allotted Time for Block 90 hours

Units of Instruction	Informational Content	Skill-Development Activities
I. How to Set-up, Operate and Shut Down Safely	Lecture and Demonstration 1. Safety (See Appendix B) a. equipment b. cylinder handling and storage c. system safety check 2. Operation a. regular adjustment b. light and adjust torch	Discussion Student demonstration of proper set-up, testing and operation
II. Pad Weld (All Positions)	Demonstration and Lecture 1. Safety (See Appendix B) 2. Forming a puddle a. flame adjustment b. torch angle c. identify puddle "eye" d. manipulation e. travel speed	Form and run a puddle Practice manipulation of the torch Discuss and review types of flame
III. Joining of Metals (All positions)	Lecture and Demonstration 1. Joints a. lap b. butt c. corner 2. Safety 3. Metal preparation 4. Soldering (Hard) a. silver	Demonstrate welding proficiency after sufficient practice.

Block 3 Title Oxy-Gas Welding and Cutting

Allotted Time for Block 90 hours

Units of Instruction	Informational Content	Skill-Development Activities
III. Joining of Metals (All Positions continued	4. Soldering (Hard), continued a. hard lead b. fluxes (special applications) 5. Soldering (Soft) a. soft lead 6. Brazing a. brass b. bronze	
IV. Oxy-Gas Cutting	Demonstration and Lecture 1. Safety 2. Regulator pressure 3. Torch adjustment a. tip size b. tip alignment	Practice until cutting skill is attained.

Instructional Aids For
Block 3

Film (16 mm) for Oxyacetylene

1. Oxyacetylene Flame - Master of Metals. U.S. Department of the Interior, Bureau of Mines, 4800 Forbes Ave., Pittsburgh, Pennsylvania 15213.

2. Manual Cutting A Bevel Free Hand. Norwood Films, 926 New Jersey Ave., N.W., Washington, D.C. 20001.

3. Fundamentals of Alloy Brazing. National Association of Plumbing Contractors, 1816 20th Street, N.W., Washington, D.C. 20009.

4. Fundamentals of Silver Brazing. Handy & Harmon, 850 3rd Ave., New York, New York 10022.

Books

1. Giachino, J.W., William Weeks and Elmer Brune. Welding Skills and Practices. American Technical Society, Chicago, Illinois 60637. Chapters 22-28.

2. Kennedy, Gower A. Welding Technology. Howard W. Sams & Co., Inc., 4300 W. 62nd Street, Indianapolis, Indiana 46202. Chapters 7-12.

Block 4 Title Metal Arc Welding

Allotted time for block 365 hours

Units of Instruction	Informational Content	Skill-Development Activities
I Fundamentals of Arc Welding	Lecture and Demonstration 1. Safety 2. Introduction to electric welding 3. Sources of heat 4. Basic welding terms 5. AWS classification of electrodes 6. Essentials of arc welding a. travel speed b. arc gap c. electrode d. current	Discussion and Questions
II Strike and Maintain the Arc	Lecture and Demonstration 1. Safety 2. Methods of striking the arc a. scratching motion b. tapping motion 3. Machines and accessories 4. Safety equipment (protective) 5. Electrical sources 6. Ventilation	Discussion and Questions Fit protective equipment Practice - Maintaining the Arc
III Pad Welds	Lecture and Demonstration 1. Safety 2. Beads a. stringer b. crescent c. figure eight d. weave	Safety test Practice beads

Block 4 Title Metal Arc Welding

Units of Instruction	Informational Content	Skill-Development Activities
III Pad Welds, continued	3. Amperage 4. Travel speed 5. Arc length 6. Bead sequence 7. Rod angle 8. Electrodes 9. Conservation of materials 10. Basic positions(review) 11. Cleaning the weld(equipment available) 12. Atmospheric contamination 13. Starting and stopping the bead	Practice travel speed Identify electrodes using AWS system numbering Students will pad weld in the four basic positions
IV Lap Joints (All Positions)	Lecture and Demonstration 1. Structure of metals 2. Preparation of metal 3. Types of laps a. single lap b. double lap c. strap lap 4. Polarity 5. AC and DC current 6. Review basic welding terms 7. Short review of basic joints	Discussion and Questions Prepare metal for welding Change polarity during welding cycle Practice until proficient
V Butt Joints (All Positions)	Lecture and Demonstration 1. Porosity 2. Types of butt joints a. open butt(square and bevel) b. closed butt	Discussion and review of math Prepare open and closed butt joints for welding

Block 4 Title Metal Arc Welding

Units of Instruction	Informational Content	Skill-Development Activities
V Butt Joints, continued	3. Backing blocks 4. Measuring metals 5. Basic welding symbols 6. Review 7. Short Math test 8. Test weld	View basic welding symbols Measure backing blocks prior to installation Practice until proficient, using stringer and weave beads
VI T Joint Fillet Welds (All Positions)	Lecture and Demonstration 1. Properties of metal 2. Bead sequence a. multiple pass 3. Distortion 4. Tacking metal 5. Positioning metal 6. Selecting proper electrodes 7. Throat of weld 8. Bead pile up 9. Overlap 10. Undercutting 11. High and low current 12. Tack welds	Discussion and Questions Position and tack metal to prevent distortion Review AWS classification system Practice until proficient
VII Corner Joints (Fillet) (All Positions)	Lecture and Demonstration 1. Characteristics of the electrode 2. Speed and motion 3. Heat input	Discussion and Questions Clean and service machines Practice speed and motion

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Block 4 Title Metal Arc Welding

Units of Instruction	Informational Content	Skill-Development Activities
VII Corner Joints, continued	4. Arc blow (magnetic) 5. Forces of gravity 6. Work and heat relationship 7. Maintenance of equipment	Practice until proficient
VIII Edge Joints (All Positions)	Lecture and Demonstration 1. Metal preparation 2. Math review 3. Basic print reading 4. Shop sketches 5. Shop projects (discussion) 6. Preparation of test specimens	Review and testing Plan shop projects
IX Groove Welds (All Positions)	Test procedures	Testing
X Pipe Welds (All Positions)	Lecture and Demonstration 1. Preparation of pipe 2. Pipe beveling cutting apparatus 3. Use of templates 4. Use of contour marker 5. Making templates 6. Cut branch without template 7. Laying parallel to pipe and branch 8. Spacing of ordinates	Discussion and Questions Make templates Weld pipe roller and bell Hole position Cut branch (NOTE) Units of pipe welding can be very affectively used with students who may advance more rapidly than others.

Instructional Aids For
Block 4

Films

1. Inside of Arc Welding. A.O. Smith Corporation, P.O. Box 584, Milwaukee, Wisconsin 53201.

2. Arc Welding Electrode Selection. Hobart Brothers Company, Troy, Ohio 45373.

3. Arc Welding of Stainless Steel. Syndicated Films, 1022 Forbes Ave., Pittsburgh, Pennsylvania 15219.

Transparencies

1. What is Arc Welding? Both edges of metal being heated by the arc and flowing together are shown. 1 transparency with 2 overlays - 7 colors.

2. Why Weld? A comparison between a rivet joint and a weld joint. 1 transparency 2/1 overlay - 3 colors.

3. Most Common Types of Welding. 1 transparency - 4 colors.

4. DC Motor Generator Welder. 1 transparency - 2 colors.

5. DC Welding Circuit. 1 transparency - 2 colors.

6. AC Welder. 1 transparency - 3 colors.

7. Welder's Dress. 1 transparency - 2 colors.

8. Accessories. 1 transparency - 2 colors.

9. Grounding. 1 transparency - 2 colors.

10. Polarity-DC Generator. 1 transparency with 1 overlay - 3 colors.

11. Welding Process. Illustrates the reaction of the electrode and the metal. 1 transparency - 3 colors.

12. AWS Classification Numbers. 1 transparency - 5 colors.

13. Color Codes. Markings on electrodes to tell their use, both old and new methods. 1 transparency with 1 overlay - 7 colors.

14. Mild Steel Electrode Selection. 1 transparency - 3 colors.

15. Electrode Chart. Gives the vital information about the various sizes. 1 transparency - 2 colors.

Order transparencies from J.S. Latta, Inc.
P.O. Box 1276, Huntington, West Virginia 25715

Transparencies (continued)

16. Striking the Arc. Shown by the scratch method and the poke method. 1 transparency with 1 overlay - 4 colors.

17. Electrode Movement. 1 transparency - 3 colors.

18. Picking Up Weld. Method for starting weld after it has been interrupted. 1 transparency - 3 colors.

19. Weaving. 1 transparency - 2 colors.

20. Terms Applied to Weld. 1 transparency - 3 colors.

21. Arc Welding Bead Faults. 1 transparency - 2 colors.

22. Porous Weld. 1 transparency - 3 colors.

23. Incomplete Penetration. 1 transparency - 3 colors.

24. Warping. 1 transparency - 3 colors.

25. Under Cutting. 1 transparency - 3 colors.

26. Cracked Welds. 1 transparency - 3 colors.

27. Poor Appearance. 1 transparency - 3 colors.

28. Poor Fusion. 1 transparency - 3 colors.

29. Brittle Welds. 1 transparency - 3 colors.

30. Spatter. 1 transparency - 3 colors.

31. Magnetic Blow. 1 transparency - 3 colors.

32. Welding Stress. 1 transparency - 3 colors.

33. Powdered Metal Electrodes. 1 transparency - 2 colors.

34. Electrode Coatings. 1 transparency - 4 colors.

35. Types of Welding Joints. 1 transparency - 2 colors.

36. Four Pass Butt Weld. 1 transparency with 4 overlays - 3 colors.

37. Three Pass Fillet Weld. 1 transparency with 3 overlays - 5 colors.

38. Lap Weld. 1 transparency - 3 colors.

39. Arc Welding Positions: Flat, Vertical, Horizontal and Overhead. 1 transparency with 3 overlays - 5 colors.

Transparencies (continued)

40. Welding Symbols. 1 transparency - 2 colors.

41. Basic Arc and Weld Symbols. 1 transparency with 1 overlay - 3 colors.

42. Cutting A Plate With A Electrode. 1 transparency with 1 overlay - 3 colors.

Film Loops

1. Advanced Electric Arc Welding. Robert S. Carlson. See DCA Films Inc., 4425 W.E. 130th, Portland, Oregon 97236.

2. Welding Skills and Practices. Giachino, J.W., William Weeks and Elmer Brune. American Technical Society, 5608 Stone Island Avenue, Chicago, Illinois 60637.

3. New Lessons in Arc Welding. Lincoln Electric Co., Coit Road, Cleveland, Ohio 44117.

4. Welding Technology. Kennedy, Gower A. Howard W. Sams Co., 4300 W. 62nd Street, Indianapolis, Indiana 46206.

Block 5 Title Metallic Inert Gas (MIG)

Allotted time for block 100 hours

Units of Instruction	Informational Content	Skill-Development Activities
I Set up and Safe Operation	Lecture and Demonstration 1. Equipment 2. Safety 3. Machine adjustment 4. Flow meter 5. Wire feed 6. Gun a. operation b. maintenance 7. Metal preparation	Demonstrate safe procedure and proper technique
II Weld Mild Steel (All Positions)	Lecture and Demonstration 1. Metal preparation 2. "Tee" joint weld 3. Lap joint weld 4. Butt weld 5. Pipe weld	Produce visually sound welds
III Weld Aluminum (All Positions)	Lecture and Demonstration 1. Metal preparation 2. Tee joint 3. Lap joint 4. Butt weld	Produce visually sound welds
IV Weld Stainless Steel (All Positions)	Lecture and Demonstration 1. Metal preparation	Produce visually sound welds

Block 5 Title Metallic Inert Gas (MIG)

Units of Instruction	Informational Content	Skill-Development Activities
IV Weld Stainless Steel (continued)	2. Tee joint 3. Butt weld 4. Pipe weld	

Instructional Aids for

Block 5

References

1. Welding Skills and Practices. Giachino, J.W., Weeks, Willian and Brune, Elmer. American Technical Society, 848 E. 58th Street, Chicago, Illinois 60637.

2. Welding Technology. Kennedy, Gower A. Howard W. Sams & Co., 4300 W. 62nd Street, Indianapolis, Indiana 46206.

Films (16mm)

1. Micro-wire Welding. Hobart Brothers Company, Box DM-440, Troy, Ohio 45373.

2. Micro-wire Pipe Welding. Hobart Brothers Company, Box DM-440 Troy, Ohio 45373.

3. Arc Welding of Stainless Steel. Syndicated Films, 1022 Forbes Avenue, Pittsburgh, Pennsylvania 15219.

4. Aluminum Welding. Reynolds Metal Company, P.O. Box 2346, Richmond, Virginia 23218.

5. Welding Advances with Aluminum. Association Films, 324 Delaware Avenue, Oakmont, Pennsylvania 15139.

6. Aluminum Metal of Many Faces. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh Pennsylvania 15213.

7. Aluminum. Modern Talking Picture Service, 2000 L Street, S.W., Washington, D.C. 20036.

8. Good As New, If Not Better. Color, sound, 15 min. Miller Electric Manufacturing Co., P.O. Box 1087, Appleton, Wisconsin 54911.

9. Short Circuiting Metal Transfer. Color, sound, 25 min. Miller Electric Manufacturing Co., P.O. Box 1087, Appleton, Wisconsin 54911.

10. Arc Welding Methods. Color, sound, 28 min. Miller Electric Manufacturing Co., P.O. Box 1087, Appleton, Wisconsin 54911.

11. Facts About the Prevention and Control of Distortion in Arc Welding. Color, 20 min. James F. Lincoln Arc Welding Foundation, P.O. Box 3035, Cleveland, Ohio 44117.

12. The Story of Arc Welding. Color, 24 min., U.S. Department of the Interior, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213.

Films (16mm) continued

13. Arc Welding: Safety and Operations. Color, 13 1/2 min. Aims Instructional Media Service, Inc., P.O. Box 1010, Hollywood, California 90028.

14. Arc Welding Electrode Selection. Color, 20 min. Hobart Brothers, Box DM-440. Troy, Ohio 45373.

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Block 6 Title Tungsten Inert Gas (TIG) (Base Metals & Weld Requirements will determine what gas will be used.)

Allotted time for block 100 hours

Units of Instruction	Instructional Content	Skill-Development Activities
I Setup and Safe Operation	Lecture and Demonstration 1. Equipment 2. Safety 3. Machine adjustment 4. Flowmeter 5. Metal preparation 6. Electrode preparation	Discussion
II Weld Aluminum (All Positions)	Lecture and Demonstration 1. Metal preparation 2. Electrode preparation 3. Tee joint 4. Lap joint 5. Butt weld 6. Pipe weld	Practice until visually sound welds can be produced.
III Weld Mild Steel(All Positions)	Lecture and Demonstration 1. Metal preparation 2. Electrode preparation 3. Tee joint 4. Butt weld 5. Pipe weld	Produce visually sound welds.
IV Weld Stainless Steel (All Positions)	Lecture and Demonstration 1. Metal preparation 2. Electrode preparation	Produce visually sound welds.

Instructional Aids for

Block 6

References

1. Welding Technology. Giachino, J.W., W. Weeks, and G. S. Johnson. American Technical Society, 5608 Stony Island Avenue, Chicago, Illinois 60637.

2. Welding Skills and Practices. Giachino, J.W., W. Weeks, and Elmer Brune. American Technical Society, 848 E. 58th Street, Chicago, Illinois 60637.

3. Welding Technology. Kennedy, Gower A. Howard W. Sams Co., Inc.,4300 W. 62nd Street, Indianapolis, Indiana 46206.

4. Welding Principles and Practices 1976. Sachs, Raymond J. Bennett Books Department 856, 809 W. Detweiller Drive, Peoria, Illinois 61614.

Films (16mm)

1. Gas Tungsten-Arc Welding Process. Color, sound, 25 min. Miller Electric Manufacturing Co., P.O. Box 1087, Appleton, Wisconsin 54911.

2. Good As New, If Not Better. Color, sound, 15 min. Miller Electric Manufacturing Co., P.O. Box 1087, Appleton, Wisconsin 54911.

3. Short Circuiting Metal Transfer. Color, sound, 25 min. Miller Electric Manufacturing Co., P.O. Box 1087, Appleton, Wisconsin 54911.

4. Arc Welding Methods. Color, sound, 28 min. Miller Electric Manufacturing Co., P.O. Box 1087, Appleton, Wisconsin 54911.

5. Facts About the Prevention and Control of Distortion in Arc Welding. Color, 20 min. James F. Lincoln Arc Welding Foundation, P.O. Box 3035, Cleveland, Ohio 44117.

6. The Story of Arc Welding. Color, 24 min. U.S. Department of the Interior Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213.

7. Arc Welding: Safety and Operations. Color, 13 1/2 min. Aims Instructional Media Service, Inc., P.O. Box 1010 , Hollywood, California 90028.

8. Arc Welding Electrode Selection. Color, 20 min. Hobart Brothers, Box DM-440 Troy, Ohio 45373.

9. Micro-Wire Welding. Hobart Brothers Company, Box DM-440, Troy, Ohio 45373.

10. Micro-Wire Pipe Welding. Hobart Brothers Company, Box DM-440, Troy, Ohio 45373.

Films(166mm) continued

11. Arc Welding of Stainless Steel. Syndicated Films, 1022 Forbes Avenue, Pittsburgh, Pennsylvania 15219.

12. Aluminum Welding. Reynolds Metal Company, P.O. Box 2346, Richmond, Virginia 23218.

13. Welding Advances With Aluminum. Association Films, 324 Delaware Avenue, Oakmont, Pennsylvania 15139.

14. Aluminum: Metal of Many Faces. U.S. Department of the Interior, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213.

15. Aluminum. Modern Talking Picture Service, 2000 L Street, S.W., Washington, D.C.,20036.

Block 7 Title Fabrication

Allotted time for block 100 hours

Units of Instruction	Informational Content	Skill-Development Activities
I Related Math	Lecture and Demonstration 1. Fractions a. multiplication b. addition c. subtraction d. division 2. Decimal conversions 3. Circular and angular measurement 4. Simple equations	Test and evaluate
II Layout and Measurement	1. Acquaint students with layout and measuring tools. a. rule b. square c. trammel d. plumb bob e. level f. combination set	Practical application by using skill test
III Blueprint Reading	Lecture and Demonstration 1. Three view drawing 2. Drawing symbols 3. Sketching 4. Welding symbols 5. Cross-section	Practical application by doing

Block 7 Title Fabrication

Units of Instruction	Informational Content	Skill-Development Activities
IV Assembly	Lecture and Demonstration 1. Layout 2. Alignment and fitting 3. Holding techniques 4. Welding techniques	Fabrication of the required assemblies

Instructional Aids For
Block 7

References

1. Elementary Blueprint Reading. Delmar Publishing, Inc., 50 Wolf Road, Albany, New York 12205.

Films

The Jam Handy Organization. 18 min. 2821 E. Grant Boulevard, Detroit, Michigan 48211.

1. Layout Tools and Measuring Instruments (Kit A)
   Layout Work (Part 1)
   Layout Work (Part 2)

2. Fundamentals of Benchwork Series (Kit B)
   Measuring and Measurements (Part 1)

3. The Toughest Inch (the building of a pipeline). Film Scheduling Center. 2323 New Hyde Park Road, New Hyde Park, New York 11040.

Block 8 Title Testing and Qualifications

Allotted time for block 85 hours

Units of Instruction	Informational Content	Skill-Development Activities
I Rules and Regulations	1. General Rules a. application b. responsibility c. ability d. procedure e. evaluation f. eligibility	Class discussion
II Operator Qualifications	1. Standards 2. a. groove welds 1. root bend 2. face bend b. fillet welds 1. fillet weld soundner test c. material 1. carbon content d. test results required 1. B 3.0 -41T section 209 e. retests 1. section 210	All tests will be in accordance with AWS criteria.
III Information Form and Certificate	1. Test results a. certificate awards	

Instructional Aids For
Block 8

References

Standard Qualification Procedure. American Welding Society, 1973, 2501 Northwest 7th Street, Miami, Florida 33125.

Films (16 mm)

Guided Bend Test. United World Films, Inc., 1445 Park Avenue, New York, New York 10029.

Block 9 Title Specialized Processes

Allotted time for block 35 hours

Units of Instruction	Informational Content	Skill-Development Activities
I Arc Cutting	Lecture and Demonstration 1. Safety 2. Carbon arc cutting a. power source b. amperage c. electrode d. cutting torch 3. Procedure a. gouging b. cutting c. beveling 4. Other arc cutting processes a. arc cutting (carbon electrode) b. plasma-arc c. arc-oxygen d. tungsten-arc	Discussion Practice to develop skill
II Flux-covered Arc Welding	Lecture and Demonstration 1. Safety 2. Set up equipment 3. Wire electrode 4. Shielding gas 5. Basic adjustments a. travel speed b. gun angle c. wire stickout d. tip to work distance	Discussion of safety and carbon hazard set up Practice

Block 9 Title Specialized Processes

Units of Instruction	Informational Content	Skill-Development Activities
III Submerged Arc Welding	Lecture Safety 1. Equipment a. automatic process	Informational purposes only
IV Plamsa-Arc Welding	Lecture Safety 1. Equipment a. nontransferred arc b. transferred arc	
V Electron Beam Welding	Lecture Safety 1. Equipment a. process	
VI Laser Beam Welding	Lecture Safety 1. Equipment a. process	
VII Electroslag and Electrogas Welding	Lecture Safety 1. Equipment a. process	

Block 9 Title Specialized Processes

Units of Instruction	Informational Content	Skill-Development Activities
VIII Atomic Hydrogen Welding	Safety 1. Equipment 2. Advantages	
IX Resistance Welding	Lecture and Demonstration Safety 1. Set up equipment 2. Metal preparation a. spot welding b. seam welding	Discussion and Practice
X Hard-surfacing	Lecture and Demonstration Safety 1. Types of wear 2. Hard-surfacing metallurgy 3. Preparing for hard-surfacing 4. Procedure 5. Spray hard-surfacing 6. Basic hard-surfacing jobs	Discussion Practice

Instructional Aids for

Block 9

References

1. Welding Skills and Practices. Giachino, J.W., William Weeks and Elmer Brune. American Technical Society, Chicago, Illinois 60637.

2. Welding Technology. Kennedy, Gower A. Howard W. Sams Company, 4300 W. 62nd Street, Indianapolis, Indiana 46206.

Block 10 Title Pre-employment Training

Allotted time for block 15 hours

Units of Instruction	Informational Content	Skill-Development Activities
I Employment Application	Lecture and Instruction, filling out application forms 1. Social security 2. Reference 3. Experience 4. Emergency information 5. Personal appearance 6. Interview 7. Follow up Lecture and Discussion of: 1. Jobs available and average wages 2. Placement officials 3. Apprenticeship 4. Virginia Employment Commission 5. Civil service 6. Armed services 7. Workmens compensation law 8. Unemployment insurance law	Class discussion Complete sample application Practice interview Practice interview Class discussion
II Employer-Employee Relationship	Lecture and Discussion 1. Employer responbitilies-work conditions a. clean work areas b. safety equipment c. work day hours	Class questions and discussion

Block 10 Title Pre-Employment Training

Units of Instruction	Informational Content	Skill-Development Activities
II Employer-Employee Relationship (continuted)	1.Vacation 2.Insurance 3.Incentive bonds 4.Guidance service 5.Wages Employee Responsibility 1.Punctuality 2.Knowledge 3.Safe work habits 4.Proper dress 5.Good character traits a. honesty b. dependability c. high morality d. cooperative 6.Reasonable amount of work per day 7.High aspirations	

Instructional Aids For
Block 10

Films

1. Your Job: You and Your Boss. Bureau of Teaching Materials, Virginia Virginia Department of Education, Richmond, Virginia 23216.

2. Your Job: Good Work Habits. Bureau of Teaching Materials, Virginia Virginia Department of Education, Richmond, Virginia 23216.

Film Strips and Cassettes

Eye Gate House
1. The ABC's of Getting and Keeping a Job
2. Preparing for the Job You Want
3. Applying for the Job You Want
4. On the Job
5. Budget Your Money
6. Labor Unions
7. Health Rules to Follow
8. Quiz-Strips

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APPENDIX A

UNIT GUIDE EXAMPLE, BLOCK 3

Description of the Unit Guide

The unit guide which follows will serve as an example of the preparation needed for teaching the various units of instruction. The teacher should develop unit guides for each block in the curriculum guide. In this sample guide, lesson plans are included for selected lessons only. A completed unit guide should contain a lesson plan for each lesson listed in the block breakdown. Teachers should develop their own content. The lesson plans included in this publication are intended to serve only as examples.

The approach for the unit guide is suggestive only and each teacher may elect to develop a format to suit personal preferences.

UNIT GUIDE

COURSE_____

UNIT NO._____

NAME OF UNIT_____

UNIT OBJECTIVES

As a result of your teaching and student learning, students will be able to do the following: (state behavioral obejctives)

1. Given the necessary equipment, the student will be able to set up, operate, and safely shut down the oxy-gas welding and cutting equipment.
2. Identify three types of flame used in oxy-gas welding and cutting.
3. Select and adjust the following types of flames:
   A. Carburizing flame
   B. Oxidizing flame
   C. Neutral flame
4. Given a soap and water solution, the student will be able to check safely the oxy-gas equipment.
5. Given metals, filler materials, fluxes, and proper size welding tips, the student will be able to weld cast iron, aluminum, stainless, and mild steels.
6. Given track torches, the student will be able to do bevel cutting.
7. Given circle cutting equipment, the student will be able to cut a circle.
8. Given torches and cutting tips, the student will be able to cut straight lines and pierce holes.
9. Given the necessary equipment, the student will be able to burr with a chisel, align, and tack metal, and do backhand welding.
10. Given a rule and metal scribe, the student will be able to measure, cut, and properly fit metal for welding.
11. Learn and apply safe working habits in all job activities.

LESSON BREAKDOWN

UNIT TITLE _____

No.	Doing Lessons	No.	Knowing Lessons
	How to:		Technical Topics
D3-1	Set up equipment	K3-1	Operate mainfold system
D3-2	Light hand torch	K3-2	Pressure regulators
D3-3	Select welding tip	K3-3	Tip sizes
D3-4	Select proper flame	K3-4	Types of flames
D3-5	Adjust flame	K3-5	Reading pressure gauges
D3-6	Safety check system	K3-6	Different methods to use
D3-7	Weld mild steel	K3-7	Clamping to prevent distortion
D3-8	Weld aluminum	K3-8	Selection of filler materials
D3-9	Weld stainless steel	K3-9	Application of fluxes
D3-10	Baze mild steel	K3-10	Heat application
D3-11	Braze cast iron	K3-11	Manipulation of the torch
D3-12	Bevel cutting	K3-12	Tip alignment
D3-13	Straight parallel lines	K3-13	Proper position of the tip
D3-14	Cut straight lines	K3-14	Selection correct speeds
D3-15	Cut a circle	K3-15	Conservation of gases
D3-16	Using circle cutter attachment.	K3-16	Alignment and tack methods
D3-17	Pierce holes	K3-17	Heavy metal plates
D3-18	Operate track torch	K3-18	General topics
D3-19	Burr with a chisel	K3-19	How acetylene is made
D3-20	Align and tack	K3-20	Manufacture of welding and cutting attachments
	Review of block 3	K3-21	Social Security
		K3-22	Workmen's compensation

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TEACHING EXPEDIENTS

(Example)

References-Textbooks

1. Welding Skills and Practices. Giachino, Weeks and Brune

2. Welding Processes. Griffin and Rhoden

Project-Activity Materials

Oxy-gas tanks and hoses
Cutting and welding attachments
Metals
Filler materials
Torch lighters
Brushes(cleaning)
Safety Equipment

Demonstration Equipment

Welding table
No. 6 welding tip
Portable tanks and gauges
Four pieces of metal
16 gauge
Lighter
Brush
Goggles
Gloves
Hammer

Other Materials, Equipment

Overhead projector
Transparencies

Resource Persons

Pocahontas Welding Supply, Bluefield, West Virignia

Southern Gas, Bristol, Virginia

Westmoreland Mining, Appalachia, Virginia

Pittson Corporation, Lebanon, Virginia

Bristol Steel, Bristol, Virginia

Black Diamond Enterprises, Bristol, Virginia

SUGGESTED METHOD OF APPROACH
(Example)

The following method of approach for this course unit is suggestive only. However, if you have had little experience in teaching the content of this unit. it is advisable that you follow the approach in detail for your first teaching. As you gain experience, new ways to demonstrate and make information topics dynamic will come to you and these should be recorded in the spaces between the steps in the teaching approach. The teaching approach below will run from the first to the last day of the unit. You will have to decide how much to cover each day the class meets.

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
1. Introduce unit(30 minutes) A. Explain manifold system B. Safety check hoses and lines C. Review welding positions	1. Assemble oxy-gas area A. Students tour manifold area B. Prepare soap and water solution C. Students perform safety check of equipment Activity 3 hours
2. How to operate manifold system (K3-1) (45 minutes) A. Discussion of station valve area B. Operate station valves C. Show station valve disassembled	2. Assemble welding stations A. Students discuss valve area B. Assemble valves C. Turn on gases D. Shut down manifold system Activity 3 hours
3. Set up equipment (D3-1) (45 minutes) A. Discuss portable welding equipment B. Show transparencies C. Operate portable tanks	3. Classroom assembly A. View transparencies B. Students discuss safety techniques C. Students attach hoses and gauges to tanks D. Discuss pressure readings
4. Pressure regulators (K3-2) (45 minutes) A. Setting welding pressure B. Damage to regulators C. Single and double stage regulators	4. Assemble oxy-gas area A. Observe techniques B. Set pressures C. Safety check hoses D. Bleed tank pressures E. Close system Activity 3 hours

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
5. Tip sizes (K3-3) (45 minutes) A. Discuss tip sizes 00 to 9 B. Demonstrate proper care and cleaning C. Discuss welding techniques	5. Assemble welding stations A. Students observe cleaning and care methods B. Students attach welding tips to hoses C. Practice welding techniques, tip angle, etc. Activity 3 hours
6. Light torches (D3-2) (30 minutes) A. Safe position to eliminate burns B. Proper mixture for welding C. Discuss mixing chamber D. Review safety techniques	6. Assemble welding stations A. Clean tips B. Safety check hoses C. Light torches D. Observe flames E. Practice safe handling of torch and tanks Activity 3 hours
7. Type flames (K3-4) (30 minutes) A. Show movie B. Discuss welding techniques	7. Assemble classroom A. Selected students give short safety lecture B. Remaining time given to VICA Activity 3 hours
8. Select proper flame (D3-4) (45 minutes) A. Brief lecture B. Neutral flame C. Carbon flame D. Oxygen flame	8. Assemble welding stations A. Prepare metal B. Start to weld C. Short beads D. Torch manipulation Activity 3 hours
9. Adjust flame (D3-5) (30 minutes) A. Demonstrate proper adjustments B. Manipulative techniques C. Review positions	9. Welding stations A. Continuous beads B. Practice beads Activity 3 hours
10. Safety check manifold system (D3-6) (45 minutes) A. Brief review of safety practices B. Methods to use (K3-6) C. Explain purging by nitrogen	10. Manifold area A. Prepare soap and water solution B. Apply to all fitting and joints of system C. Observe reactions to leaks D. Bleed system, tighten all fittings Activity 3 hours

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
11. Weld mild steel (D3-7) (45 minutes) A. Preparing metal B. Basic joints C. Prepare corner joint D. Prepare edge joint	11. Welding tables A. Prepare metals B. Use filler materials C. Make butt joints D. Make lap joints E. Make tee joints F. Make corner joints G. Make edge joints Activity 30 hours
12. Weld aluminum (D3-8) (45 minutes) Continuation of D3-7, nonferrous metals	12. Assemble classroom, 45 minutes per day 24th day 28th day 30th day 32nd day
13. Select filler materials (K3-8) (45 minutes)	13. View filler materials
14. Apply fluxes (K3-9) (45 minutes)	14. Note different types of fluxes
15. Heat application (K3-10) (45 minutes)	15. Perform magnetic and other tests illustrate types of metal
16. Review torch manipulation	16. View cutting techniques for nonferrous metals Activity 30 hours
17. Weld stainless steel (D3-9) (45 minutes) Continuation of D3-7, D3-8	17. Welding tables A. Continue metal preparation B. Continue basic joints C. Review fluxes and filler materials D. Practice all position welding E. Review flames for nonferrous metal welding Activity 21 hours
18. Field Trip NOTE: If field trip is not possible this time, day will be devoted to VICA activities.	18. Assemble classroom for field trip, (Visit selected Technical School programs) Activity 6 hours

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
19. Braze mild steel (D3-10) (45 minutes) Braze cast iron (D3-11) (45 minutes) A. Braze cast iron B. Continue D3-7, D3-8	19. Assemble classroom A. View completed samples of previous work B. Return welding tables C. Prepare cast iron by drilling holes D. Discuss brazing techniques E. Safety discussion F. Continue joints Activity 24 hours
20. Unit test	20. Classroom assembly A. Take Unit Test I B. Self study C. Review own accomplishments D. Those with reading problems may move to the library after test. Activity 3 hours
21. Bevel cutting (D3-12) (45 minutes) A. Set up track torch B. Cut 30° bevel C. Cut 25° bevel	21. Assemble cutting room A. Set up equipment B. Line metal C. Each student bevels test specimen 1/4" metal D. Prepare back plate for test coupon Activity 9 hours
22. Straight parallel lines (K3-13) (45 minutes) A. Lay out template B. Run parallel lines	22. Classroom assembly A. Practice straight lines B. Make template C. Move to welding area D. Practice laying out template Activity 3 hours
23. Use circle cutter (K3-14) (45 minutes) A. Lay out circle B. Set up equipment C. Cut a circle D3-14 1. Position tip 2. Measure cutting attachments	23. Assemble cutting room A. Observe B. Cut 6" circle C. Cut 12" circle D. Practice tip angle and positions Activity 6 hours

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
24. Proper position of tip (K3-15) (45 minutes) A. Raise tip to pierce B. Operate track mechanism	24. Assemble welding stations A. Practice piercing holes B. Pierce 2" hole C. Measure hole (diameter) Activity 3 hours
25. Selecting correct speeds (K3-16) (30 minutes) A. Discuss cutting speeds B. Operate track mechanism	25. Assemble cutting room A. Enter discussion B. Set angles 30°, 25°, 20° C. Operate track mechanism high and low speeds Activity 3 hours
26. Operate track torch (D3-16) (45 minutes) A. Prepare test metal coupons	26. Assemble cutting room A. Select metal to be tested B. Prepare metal to be tested
27. Burr with a chisel (D3-17) (20 minutes) A. Position of chisel B. Discuss reasons for burring	27. Classroom assembly A. Review results of unit test B. Discuss self-evaluation methods C. Review guided bend testing D. Practice burring Activity 3 hours
28. Conservation of gases (K3-17) (20 minutes) A. Seat valves B. Tighten station valves to plastic seats	28. Assemble manifold area A. Review D3-7, D3-8, D3-9, D3-10, D3-11 B. Practice for guided bend test Activity 3 hours
29. Alignment and tack methods (K3-18) ((35 minutes) Heavy metal plated (K3-19) A. Discuss final testing	29. Classroom assembly A. Review safety B. Practice for final testing Activity 3 hours
30. Back hand weld (D3-19) (25 minutes)	30. Practice for final testing Activity 3 hours
31. Guided bend testing (20 minutes)	31. Testing Activity 19 hours
32. Test and review (45 minutes)	32. Final test Activity 6 hours

NOTE: Films and transparencies will be integrated throughout the unit as they become available.

INSTRUCTOR'S LESSON PLAN
Related Technical Information
(Example)

Unit 3
Lesson K3-1

INSTRUCTOR:

LESSON TITLE: How To Operate a Manifold System

AIM: The student will be able to set up and operate a manifold system.

TEACHING AIDS: Shop constructed system

MATERIALS: Copper pipe, black pipe, fittings, station valves, flash back apparatus, manifold, pressure gauges and tanks

REFERENCES: Welding Skills and Practices. Giachino, Weeks and Brune. American Technical Society, Chapter 22, pp. 286-291.

I. PREPARATION(of the learner)
   A. Discuss briefly, industries which use acetylene generators.
   B. Show slides of calcium carbide.
   C. Relate own experiences of explosion while using acetylene generator, (too much feed, lack of training).

II. PRESENTATION(cf the information)

Instructional Topics	Key Points (things to remember to do or say)
Manifold systems	1. A. Considerable welding B. Schools, industry C. Pipe lines D. Acetylene cylinders E. Economical F. High and low pressure, i.e., 1 lb. PSI, 15 ob. PSI G. Common uses H. Simple operation I. Production gases J. Safe operation K. Official codes L. Location to codes M. Efficiency amount welding N. Welding shops manufacturing acetylene O. Relation of low and high pressures to injection P. Service of system Q. Safety checking system R. Mixtures of soap and water

LESSON PLAN, continued

III. APPLICATION (drills, illustrations, analogies, oral questions or assignments)

A. Students put system into operation.
B. Selected students secure system.
C. Students change anti-freeze system.
D. Safety check of system will be performed by selected students who will prepare safety test for class.

IV. CHECK UP (or test--final check on students' comprehension of material presented)

A. Safety test, prepared by selected students
B. All students will sketch the system and hand in for grading.

Suggested reading for student: Welding Skills and Practices. Chapter 22, pp. 286-291.

The next lesson is: Tip Sizes

INSTRUCTOR'S LESSON PLAN
Manipulative Skills
(Example)

Unit 3
Lesson D3-1

INSTRUCTOR:

LESSON TITLE: Set up Equipment

AIM: The student will be able to set up safely and operate equipment; shut off equipment.

TOOLS AND EQUIPMENT: Welding table, cutting torch, welding tip, regulators, hose, tanks, spark lighter

MATERIALS: 1/4" x 4" x 6" mild steel plate

TEACHING AIDS: Commercial charts available from welding equipment suppliers

REFERENCES: Welding Skills and Practices. Giachino, Weeks and Brune.

I. PREPARATION(of the learner)

Setting up and operating welding equipment are operations which must be done frequently and accurately. Since this process can be dangerous, correct procedure must be learned thoroughly and practiced.

In order for the operator to do a good job and practice good safety habits, the process of setting up the equipment must be learned well.

II. PRESENTATION(of the skills)

Steps	Key Points (things to remember to do or say)
A. Select acetylene and oxygen cylinders	1. A. Check threads on valve B. Inspect safety plugs C. Check for dirt inside valve D. Crack valve to remove dust E. Secure tanks with chain
B. Connect regulators to cylinder and hose to regulators	2. A. Acetylene thread right, hose red B. Oxygen thread left, hose green C. Tighten, then inspect for cracks D. Level gauges to tanks E. Compare readings F. Don't hammer wrench when tightening G. If in doubt use soap and water to check H. Use three senses; sight, hearing, and smell

II. PRESENTATION, continued

Steps	Key Points(things to remember to do or say)
C. Install welding or burning tips	3. Select: A. Tip according to thickness of metals B. Tips vary in sizes; 00-9 C. Don't strike tip against table D. Over clean
D. Light torch	4. A. Turn on acetylene B. Hands away from torch(burns) C. Too much oxygen or acetylene D. Smoke from flame
E. Adjust flame	5. A. Oxygen B. Carbon C. Neutral D. Single, double, and triple

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III. APPLICATION(practice by learner under close supervision)

A. Students set up equipment
B. Check system with soap and water solution
C. Practice tip angles
D. Secure equipment
E. Lay out metals for next class

IV. CHECK UP(or test performance of skill to acceptable standards)
Oral Test

A. How do you determine cutting tip sizes?
B. What solution is used to check for leaks?
C. What is a blow pipe?
D. What gas is turned off first, oxygen or acetylene?

Suggested reading for student: Welding Skills and Practices. Chapter 22, pp. 286-294.

The next lesson is: How to Light a Torch

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INSTRUCTOR'S LESSON PLAN
Related Technical Information
(Example)

Unit 3
Lesson K3-2

INSTRUCTOR:

LESSON TITLE: Pressure Regulators

AIM: The student will be able to maintain and use a pressure regulator.

TOOLS AND EQUIPMENT:

MATERIALS: Cylinders, regulator, hoses, torch, carbide, water

TEACHING AIDS: Transparencies, disassembled regulator (double stage)

REFERENCES: Welding Skills and Practices: Giachino, Weeks and Brune. American Technical Society, Chapter 22, pp. 293-296.

I. PREPARATION(of the learner)
   A. View and discuss damaged regulator
   B. Demonstrate how acetylene is made
   C. (Hand out) Willie Doyle who thought all things worked better with oil.

II. PRESENTATION(of the information)

Instructional Topics	Key Points(things to remember to do or say)
A. Safety checking the regulator hose and fittings	1. A. Check for leaks B. Soap suds C. Smell (acetylene) D. Escaping air sound (oxygen) E. Tank pressure, 2500 lbs.
B. Types of regulators	2. A. Single and double stage B. Regulator case C. Working pressure D. Adjusting screw E. Valve F. Rubber diaphragm G. Spring H. Atmospheric pressure I. Gas from cylinder J. Open valve slowly K. High and low pressure L. Set pressures

PRESENTATION(of the information) continued

II. Instructional Topics	Key Points(things to remember to do or say)
C. Care and maintenance of regulators	3. A. Never use oil or regulators (fittings) B. Never thump or beat regulator C. Keep gauge cover tight and free of dirt D. Don't change with other gases E. Never use oxygen for air F. Compare gauges frequently with other units G. Don't use gauges which are damaged

III. APPLICATION(drills, illustrations, analogies, oral questions or assignments)

A. Why shouldn't you use oxygen for air? (explosive)
B. How do you adjust a regulator?
C. How would you purge oxygen and fuel passages?
D. Explain what causes regulators to become inservicable. (flashback, abuse by user, etc.)

IV. CHECK UP(or test--final check on students' comprehension of material presented)

A. Students will set up and check portable tanks for leaks, with soap and water solution.
B. Set pressures for welding operations.
C. Replace damaged parts on a flash damaged regulator.

Suggested reading for student: Welding Skills and Practices. Chapter 22, p. 283.

The next lesson is: How to Operate the Manifold System

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INSTRUCTOR'S LESSON PLAN
Manipulative Skills
(Example)

Unit 3
Lesson D3-2

INSTRUCTOR:

LESSON TITLE: How to Light a Torch

AIM: The student will be able to install welding tips, light the torch, adjust the flame and shut off the system.

TOOLS AND EQUIPMENT:

MATERIALS: 1 piece 1/4" x 4" x 8" mild steel plate

TEACHING AIDS: Portable welding equipment, charts, tips, cutting torches, transparencies

REFERENCES: Welding Skills and Practices. Giachino, Weeks and Brune. American Technical Society, Chapter 23, pp. 302-303.

I. PREPARATION(of the learner)

A. It is important for the welder to be able to install properly the correct tips and light the torch, because these operations will have to be performed many times when welding.

B. Ask questions: 1. What is a blow pipe?
2. How do you size tips?
3. What is meant by triple X flame?

II. PRESENTATION(of the skills)

Steps	Key Points(things to remember to do or say)
A. Open acetylene valve	1. A. 1/4 turn B. Regulator pressure C. Torch direction D. Leaks blow pipe fittings E. Tighten F. Hoses not fouled G. Dry rotted H. Adjust to working pressure I. Note: Tank pressures to 2500 lbs. PSI J. Manifold system to 60 lbs. PSI K. Plastic valve seats L. Explosive mixtures M. Check safety of tanks or system N. Burns

II. PRESENTATION, continued

Steps	Key Points (things to remember to do or say)
B. Spark lighter to tip (light)	1. A. Sooty flame B. Appearance of flame C. Sound D. Distance flame to tip E. Mixtures of oxygen and acetylene F. 15 lbs. PSI working G. Wet blanket in case of fire H. Safety valves I. Clogging of valve outlets J. Testing open flame K. Interchanging regulators L. Hot slag, sparks M. Ventilation

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III. APPLICATION (practice by learner under close supervision)

A. Each student will light the torch.
B. Students will be required to extinguish fire with wet blanket.
C. Each student will set working pressure by adjusting regulators.

IV. CHECK UP (or test performance of skill to acceptable standards)

A. Unit safety test (in part)
B. Oral Questions:
   1. What constitutes explosive mixtures?
   2. Where are tank safety devices located?
   3. Would you put hot metal on top of tanks? Why not?
      (Hand in, written in <u>own words</u>)

The next lesson is: Selecting the Welding Tip

UNIT TEST
(Example)

Code No._____
Name_____

ACETYLENE EQUIPMENT AND TECHNIQUES

Directions: Circle T when statement is true.
Circle F when statement is false.

1. T F The oxy-acetylene flame develops a heat of 6300 degrees F.

2. T F It generally is known that two gases are used in the oxy-acetylene process.

3. T F Oxygen is made from air by electrolysis.

4. T F Acetylene is made by adding calcium carbide to water.

5. T F There are three types of oxy-acetylene torches.

6. T F Cracking the tank is done to see if the valve is working.

7. T F The oxygen hose is identified by the color red.

8. T F The acetylene hose is equipped with left-hand threads.

9. T F If the tip used for a job is too small, it is likely to produce poor metal in the weld.

10. T F To light the torch, the oxygen is turned on first.

11. T F To turn off the lighted torch, the acetylene is turned off first.

12. T F For complete combustion, one volume of acetylene requires two and one-half (2 1/2) volumes of pure oxygen.

13. T F An excess of oxygen will result in a purplish oxidizing flame.

14. T F If the pressure is too low, it will permit the flame to burn within the tip.

15. T F The head of the torch should be inclined at an angle of 90 degrees to the plane of the weld.

16. T F The travel of the torch should be from right to left.

17. T F The welding rod should be held in a vertical position.

18. T F If the pool is large enough when filler rod is added, the sides of the beads will be overlapping.

19. T F The most common fault in welding is the presence of too much oxygen in the welding flame.

Directions: Fill in the correct word or words.

1. In the field of_____ _____oxy-acetylene welding has assumed an important place.

2. The modern system of welding include the_____and_____ processes.

3. Several flame welding processes have been introduced, all utilizing _____in combination with some fuel gas.

4. _____and_____are the two gases used in the oxy-acetylene process.

5. The two recognized systems of generating acetylene are_ _____and_____.

6. The two types of oxy-acetylene welding torches are the_____and _____type.

7. The diaphragm of a regulator may be either_____or _____.

8. Oxygen regulators are usually equipped with_____.

9. With the pressure blowpipe, acetylene pressure should range from _____to_____lbs. per square inch.

10. When "cracking" the oxygen tank, do not direct the stream of high pressure _____toward anyone.

11. On most equipment there is no danger of interchanging hose connections, because of the_____thread on the acetylene hose.

12. You would use a number____tip on metal of 7/16" to 4/8" in thickness.

13. To make adjustments on the oxygen regulator, first check to see if the adjusting screw is_____and free from_____.

14. If too much time is permitted to_____before lighting the torch, there is danger of a (an) _____.

15. When the_____flame is adjusted, the_____valve is then opened gradually.

16. If the flame is properly adjusted the sound of the welding flame will be_____.

17. There are certain welding operations in which it is desirable to have a slight _____flame.

18. When an operator observes_____floating on top of the molten metal, it should be a warning to_____.

19. The head of the torch should be inclined at an angle of about_____ degrees.

20. Too many welders make the mistake of_____or_____ their work.

Directions: Underline the correct word or words.

1. Oxygen made by the liquid air process can contain an impurity such as (nitrogen) (hydrogen).

2. Oxygen made by the electrolyic method is dangerous to handle if more than (1%) (2%) is present.

3. The acetylene in cylinders is (not compressed) (compressed).

4. Experience has proven that when the gas is used at a rate greater than (1/2) (1/7) the capacity of the cylinder per hour, the solvent will travel with the acetylene.

5. By means of the acetylene generator, it is possible to produce acetylene at less than (1/3) (1/4) (1/2) the cost of the tank acetylene.

6. Oxygen at high pressure, passes through the injector and (expands) (contracts) rapidly.

7. In the medium pressure torch, both the oxygen and acetylene are supplied to the torch at a (constant) (irregular) pressure.

8. Oxygen regulators are equipped with (1) (2) gauge(s).

9. A "small gauge" (is) (is not) necessary with the low pressure blowpipe.

10. If in doubt about the security of connections, turn on the pressure and test each connection with (soap and water) (lighted match).

11. Open the (oxygen) (acetylene) valve about 1/4 turn to light the torch.

12. A neutral flame is (yellowish) (bluish).

13. An excess of oxygen will result in a (bluish) (purplish) (oxidizing) flame.

14. If pressures of both acetylene and oxygen are too great, the flame will burn with a (harsh) (hissing) (blowing) sound.

15. When an (excess) (small) amount of acetylene is being used, the flame is ragged.

16. The travel of the torch should be from (right to left) (left to right).

17. Melting filler rod onto red hot metal (does) (does not) make a weld.

18. The most common fault in welding is the presence of (too much) (not enough) oxygen in the welding flame.

19. When molten metal from the welding rod is added to the edge of the welds which are not in fusion, a weld (is) (is not) secured.

20. Metal above the face of the plate offers (little) (more) strength to the joint.

PROGRESS CHART
(Example)

MAJOR UNITS	JOB SKILLS TO BE DEVELOPED		MAJOR UNITS	JOB SKILLS TO BE DEVELOPED
I. Metallic Arc Welding	1. Safety practices in Arc Welding			5. Beveled Butt Weld E6312
	2. Operate Arc Welding Equipment			6. Outside Corner Weld E6012
A. Arc Welding Fundamentals	3. The Welding Circuit			7. Numbers 1, 2, 3,4,5,6, use E6010 and E7018
	4. Welding Rod Classification			
	5. Straight Polarity vs. Reverse Polarity		C. Vertical	1. Make Stringer Bead E6012
Flat Position	6. Current setting and Angle of Electrodes			2. Run Fillet bead up E6012 Weave Motion
	7. Welding Symbols			
	8. Parallel Stringer Beads E6012 Electrodes			3. Run up Butt Weld "Weave Motion" E6012
	9. Start and Restart Continuous Beads E6012			4. Down Stringer Beads with E6012
	10. Single Pass Buildup E6012			5. Down Fillet Weld E6012
	11. Single Pass Square Butt Joint (Closed E6012)			6. No's. 1,2,3,4, 5 use E6012
	12. Open Square Butt Joint E6012		D. Overhead Vertical	1. Stringer use E6012
	13. Single Pass Lap Joint E6012			2. Fillet use E6012
	14. Single Pass Fillet Weld E6012			3. Butt weld use E6012
	15. Weave Bead Buildup E6012			4. Lapp Weld use E6012
	16. Use No's. 8,9,10,11,12. 13,14,15,16,17, with E6012			5. Corner Weld use E6012
	17. Multiple Pass Lap Joint E6012			6. Vee Butt Weld use E6012
B. Horizontal Position	1. Multiple Pass Lap Joint E6012			7. Perform No's. 1,2,3,4,5,6, use E6010
	2. Multiple Pass Fillet Weld E6012			
	3. Weaved Lap Weld E6012		E. Pipe Welding	1. Roll Practice Beads on pipe E6010
	4. Weaving a Fillet Weld E6012			2. Roll Square Butt Joint E6010
				3. Roll Beveled Butt Joint E6010
				4. Vertical Down Butt E6010
	87			5. Vertical Up Butt E6010

Progress Chart (continued)

MAJOR UNITS	JOB SKILLS TO BE DEVELOPED		MAJOR UNITS	JOB SKILLS TO BE DEVELOPED
F. Miscelleneous Welding Jobs	1. Outside Corner Weld E7024			6. Fillet Welds in Aluminum
	2. Fillet Weld E7024			7. Flanged Butt Welds in Aluminum
	3. Deep Grove Weld E7024			
	4. Test Weld. Unit A			
	5. Test Weld. Unit B			
	6. Test Weld. Unit C		C. Welding General Metals and Alloys	1. Welding Magnesium and Magnesium Alloys
	7. Test Weld. Unit D			
	8. Test Weld. Unit E			2. Welding Stainless Steel
	9. Test Weld. Unit F			
II. Oxygen-acetylene Weld.	1. Safe Gas Welding Practices			3. TIG Welding Stainless Steel
	2. Study of Gas Welding Equipment			
A. Gas Weld. Fundamentals	3. Study of Welding Symbols			4. Welding of Copper and Copper-Based Alloys
B. Flat Postion Welding	1. Carry a Puddin			
	2. Lay Beads with a Filler Rod			5. Welding of Nickel and Nickel-Based Alloys
	3. Weld Butt Joints			
	4. Weld Flanged Joints			
	5. Corner Joints and Lay Joints			
	6. Weld Two Joints			
	7. Test Welds			
C. Other Welding Positions and Operations	1. Vertical Weld. Horizontal Weld			
	2. Single Vee Butt			
	3. Double Vee Butt			
	4. Overhead Weld			
	5. Pipe Weld Roll Position Pipe Weld Fixed Position			
	6. Flame Cutting			
	7. Safe Cutting Practices			
	8. Cast Iron Blazing			
	9. Bronze Brazing			
	10. Brazing Cast Iron			
	11. Test Welds			
III. TIG and MIG Fundamentals	1. Tungeten Inert-Gas Shielded-Arc Weld. Proc.			
	2. Equipment for Manual TIG Welding			
	3. The Water-Cooled TIG Welding Torch			
A. Welding of Aluminum	1. Action In and Around the Welding Arc			
	2. Running Parrallel Stringer Beads on Aluminum			
	3. Making Outside Corner Welds on Aluminum			
	4. Making Butt Welds on Aluminum			
	5. Lap Welds in Aluminum			

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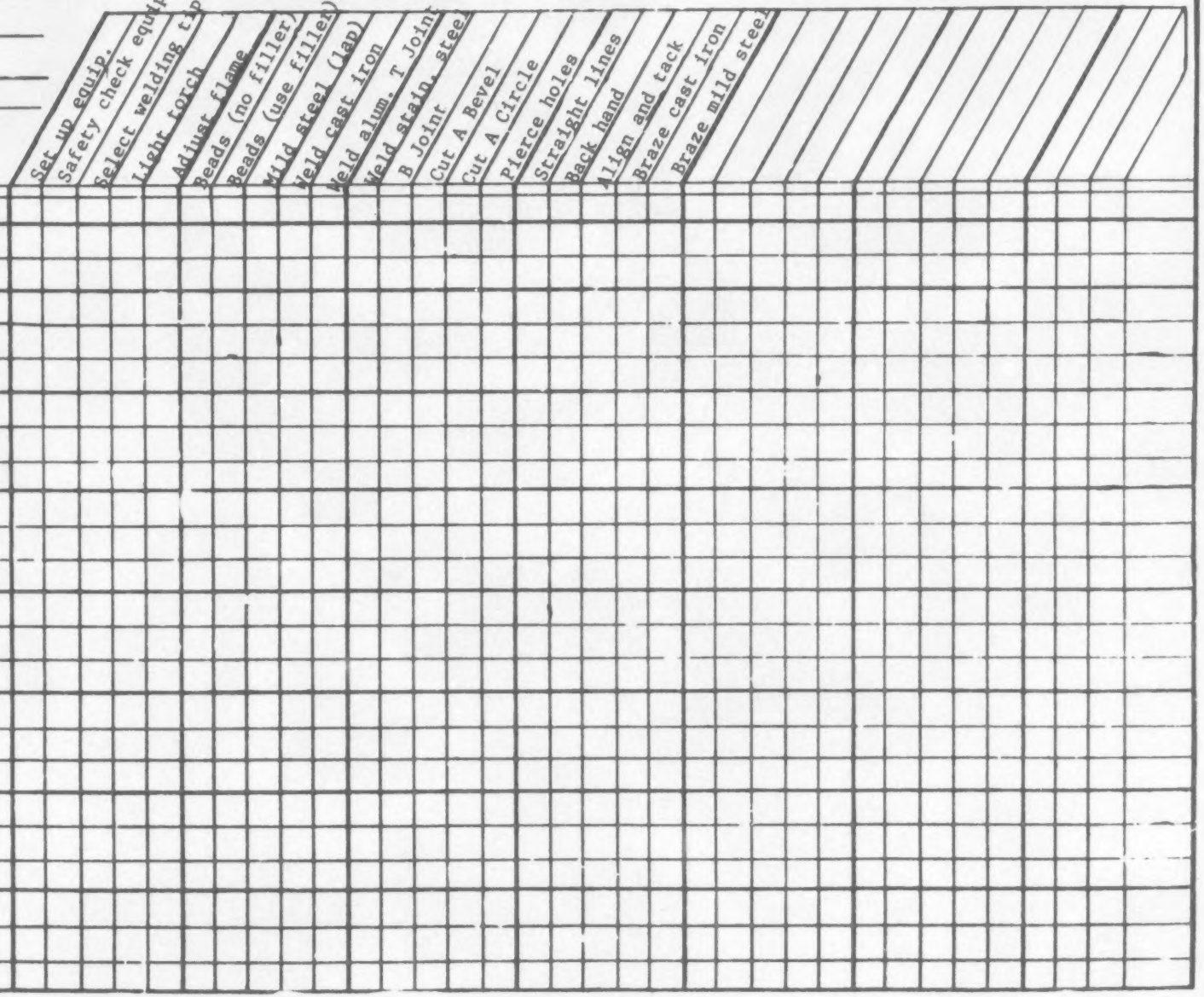
DATE ____ to ____

CLASS ____

INSTR. ____

PROGRESS CHART



Virginia Dept. of Education

INFORMATION SHEET

(Example)

Unit 3

Oxy-Acetylene Fusion of Mild Steel

Basic

I. Terms and definitions

A. Fusion welding - joining pieces of metal by heating the adjoining edges to the fusion or melting point and then to flow or run together and then cool
B. Penetration - distance from the face of the base metal to the point at which fusion ceases
C. Base metal - metal being welded
D. Alloy - a mixture of two or more elements of which one is a metal
E. Inner core - the inner white part of the neutral flame
F. Tack weld - a short weld used for temporarily holding material in place

II. Oxy-acetylene welding equipment

A. Acetylene cylinder
B. Acetylene cylinder valve
C. Acetylene fittings
D. Acetylene regulator
E. Oxygen cylinder
F. Oxygen cylinder valve
G. Oxygen fittings
H. Oxygen regulators
I. Oxygen torch valve

III. Factors determining fusion weld quality

A. Proper flame adjustment
B. Angle of tip
C. Distance from work
D. Speed of travel
E. Movement of tip

IV. Properties of a good weld

A. Consistent width
B. Straightness
C. Slightly crowned
D. Fused into base metal
E. Clear appearance

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V. Factors determining tip size selection

A. Metal thickness
B. Size of welding rod

(NOTE: Check manufacturer's recommendation.)

VI. Factors determining rod selection

A. Rod with similar properties as base metal
B. Thickness of metal

(NOTE: General rule: rod diameter to equal thickness of base metal)

VII. Purpose of filler rod

A. To add strength to weld joint

VIII. Oxy-acetylene welding flames

A. Carburizing flame
   1. Contains excess of acetylene

B. Neutral flame
   1. Contains equal parts of oxygen and acetylene

C. Oxidizing flame
   1. Contains excess oxygen

Job Sheet

(Example)

Job No. 1: Set Up Equipment

Procedure for setting up equipment:

1. Fasten cylinders in vertical position.

2. Remove caps from cylinders.

3. Crack valves to remove dust and foreign matter.

4. Connect regulator to oxygen cylinder.

   A. Turn pressure adjusting screw on regulator counter-clockwise until tension on string is released.
   B. Slowly open cylinder and tighten in open position.

5. Connect acetylene regulator to cylinder.

   A. Turn pressure adjusting screw to regulator counter-clockwise until tension on string is released.
   B. Open cylinder valve 1/2 turn, (never more than 1 1/2 turns).

6. Connect acetylene hose to regulator. (Note: All acetylene fittings have grooved rut to indicate right handed threads.)

7. Connect oxygen hose to regulator. (Note: All oxygen threads have right handed threads.)

8. Connect torch body to oxygen and acetylene hoses. Close valves.

9. Attach welding tip to torch body.

10. Turn pressure adjusting screws on oxygen and acetylene regulators until working pressures are obtained.

SHOP RULES FOR THE UNIT

(Example)

1. No horse play in shop area at anytime.
2. No paper will be allowed in scrap metal bins.
3. Drinks or food wrappers will not be left on machines or in the working area of the shop.
4. Torn or frayed clothing will not be worn in shop area.
5. Hot metal will not be disposed of in trash cans.
6. Secure oxyacetylene hoses properly to their hangers.
7. Air hoses will be kept in their place when not in use.
8. Portable tanks will be kept in their appropriate place when not in use.
9. CO_2 tanks should be chained properly at all times.
10. Welding cables should be kept from tangling and be secured properly on their machines.
11. Proper care of tools will be required at all times.
12. Tools not in use will be put in the tool room.
13. Broken tools will be reported to the instructor.
14. Broken or damaged electrical receptacles will be reported to the instructor immediately upon discovery.
15. All electrical cords will be rolled neatly and stored in the proper area.
16. Students will check in on attendance chart.
17. Smoking will be allowed only in designated areas.
18. Wall lockers will be kept locked at all times.
19. Break periods will be strictly observed.
20. The shop will be kept <u>clean</u> at all times.

APPENDIX B

SAFETY PRECAUTIONS IN WELDING OPERATIONS

SAFETY PRECAUTIONS IN WELDING OPERATIONS

Section I

General Safety Precautions

1. General

Great care should be taken in handling any type of welding equipment, to prevent personal injury from fire, explosions, or harmful agents. Both general and specific safety precautions listed below must be strictly observed by workers who weld or cut metals.

A. Do not permit unauthorized persons to use welding or cutting equipment.

B. Do not weld on wooden floors unless the floors are protected from hot metal by means of asbestos fabrics, sand, or other fireproof material. Be sure that hot sparks or hot metal will not fall on the legs and feet of the operator or on any welding equipment components.

C. Remove all flammable material such as cotton, oil, gasoline, etc. from the vicinity of welding.

D. Before welding or cutting, warn those in close proximity who are not protected by proper clothing or goggles.

E. Remove assembled parts that may become warped or otherwise damaged by the welding process.

F. Do not leave hot rejected electrode studs, steel scrap, or tools on the floor near the welding equipment. These may cause accidents.

G. Keep a suitable fire extinguisher conveniently located at all times.

H. Mark all hot metal after welding operations are completed.

2. Protection of the eyes and skin

A. General. Protective clothing and equipment must be worn during welding operations. During all oxy-acetylene welding and cutting processes, operators will use safety goggles to protect the eyes from heat, glare, and flying fragments of hot metals. During all electric welding processes, operators will use safety goggles and a hand shield or helmet equipped with a suitable filter glass (depending upon the size of the welding rods or the magnitude of the welding or cutting current), to protect against the intense ultra violet and infrared rays. Caution must be exercised by those in close proximity to the welding to protect themselves from the reflections of these rays from glass, metal or shiny surfaces.

B. Protective clothing

1. Woolen clothing should be worn instead of cotton, because the wool is not easily burned or damaged by weld metal spatter.

2. Aprons or jackets made of asbestos, cloth, or leather should be worn to provide protection against spatter of molten metal. This is especially important when welding in the vertical or overhead position.

3. The welder should wear leather brogans or boots. Trousers should be without cuffs so that the molten metal will not be caught in them.

4. Flameproof gauntlet gloves, preferably of leather, should be worn to protect the hands and arms from the rays of the arc, molten metal spatter, sparks, and hot metal. Leather gloves should be of sufficient thickness so that they will not shrivel in heat, burn through, or wear out quickly. Do not allow oil or grease to come in contact with the gloves because this will reduce their flame resistance and cause them to be readily ignited or charred.

C. Protective equipment

1. To safeguard the eyes and face from harmful light rays and particles of hot metal, goggles, spectacles, or helmets with colored lenses should be worn when welding or cutting by any process. The color of the lenses, usually blue or brown, is an added protection against the intensity of white light or glare. Colored lenses make it possible to clearly see the metal and weld.

2. Do not weld with cracked or defective shields because penetrating rays from the arc may cause serious burns. Be sure that the colored glass plates are the proper shade for arc welding. Protect the colored glass plate from spatter by using a cover glass. Replace these cover glasses when damaged or spotted by molten spatter. Note: This colored glass must be manufactured in accordance with specifications detailed in the National Safety Code for the Protection of Hands and Eyes of Industrial Workers issued by the National Bureau of Standards, Washington, D.C.

3. Two basic types of helmets are used commonly to protect eyes and all parts of the head which might come in contact with injurious rays. One type is worn on the welder's head and when not in use can be raised out of the way. The other is a hand shield type which is held over the face with one hand by means of a handle. These helmets are made of vulcanized fiber, and are dull black in color to minimize reflection.

3. Fire Hazards

A. During welding and cutting operations, sparks and molten spatter are formed which sometimes fly appreciable distances. For this reason welding or cutting should not be done near flammable materials.

B. Whenever possible flammable materials attached to or near equipment requiring welding, brazing, or cutting should be removed. If removal is not practical a suitable shield of asbestos or other heat resistant material should be used to protect the flammable material. Fire extinguishing equipment must be present for the type of fire which may be encountered.

C. When welding or cutting parts of vehicles close to the oil pan, gasoline tank, and elsewhere, care should be taken to effectively shield these parts from sparks, slag, or molten metal.

4. Ventilation

A. When using welding equipment in a closed area, make certain that proper ventilation is provided. No traces of gasoline, acetylene, or other explosive vapors should be present in the area. Station an assistant outside the danger zone. This assistant should be instructed to look for fires, and to take necessary action in case of any emergency.

B. The fumes of burning paint, or fumes generated during brazing, welding or cutting of brass, lead, zinc, and galvanized or cadmium plated parts are filled with poisonous particles of oxides, lead, or zinc. Proper ventilation must be provided.
(Warning: Under the action of an electric arc, nitrogen and oxygen from the air are converted into poisonous compounds. If welding is conducted in a confined and insufficiently ventilated space, these compounds may become highly concentrated, and if inhaled in any appreciable quantity they may cause serious disability or death.)

C. Because welding operations usually generate harmful gases, fumes and dust, adequate ventilation is essential. Local exhaust systems should be provided to remove such substances. Where the nature of the work requires further protection, special respiratory equipment should be furnished for the operator. Many unknown toxic hazards can be encountered, particularly in experimental welding of new types of materials. Required ventilation standards and standard operating procedures should be cleared with the safety representative before starting such a new operation.

5. Do not experiment with torches or regulators in any way. Do not use oxygen regulators with acetylene cylinders.

6. Always use the proper tip or nozzle, and always operate it at the proper pressure for the particular work involved. This information should be taken from work sheets or tables supplied with the equipment.

7. When not in use, make certain that the torch is not burning and that the valves are closed tightly. Do not hang the torch with its hose on the regulator or cylinder valves.

8. Do not light a torch with a match, from hot metal, or in a confined space. The explosive mixture of acetylene and oxygen might cause personal injury or property damage when ignited. Use friction lighters, stationary pilot flames, or some other suitable source of ignition.

9. When working in confined spaces, provide adequate ventilation for the dissipation of explosive gases which may be generated.

10. Keep a clear space between the cylinder and the work so that the cylinder valves can be reached easily and quickly.

11. Use cylinders in the order received. Store full and empty cylinders separately and mark the latter "empty".

12. Never use cylinders for rollers, supports, or any purpose other than for which they are intended.

Acetylene Cylinders

1. Always refer to acetylene by its full name and not by the word "gas" alone. Acetylene is very different from city or furnace gas.

2. Acetylene cylinders should be handled with care to avoid damage to the valves or the safety fuse plug. The cylinders should be stored upright in a well ventilated, well protected, dry place at a safe distance from highly combustible materials such as oil or paint. Do not store the cylinders near radiators, furnaces, or in any above-normal temperature area. The heat will increase the pressure which may cause the safety fuse in the cylinder to blow out. Storage areas should be located away from elevators, gangways, or other places where there is danger of their being knocked over or damaged by falling objects.

3. A suitable truck, chain, or strap should be used to prevent cylinders from falling or being knocked over while in use. Cylinders should be kept at a safe distance from the welding operation so that there will be little possibility of sparks, hot slag, or flames reaching them. They should be kept away from radiators, piping systems, layout tables, etc., which may ground electrical circuits. Nonsparking tools should be used when changing fitting on cylinders of flammable gases.

4. Never use acetylene from cylinders without reducing the pressure with a suitable pressure reducing regulator. Never use acetylene at pressures in excess of 15 psi.

5. Before attaching the pressure regulators, open each acetylene cylinder valve for an instant to blow dirt out of the nozzles. Wipe off the connection seat with a clean cloth. Do not stand in front of valves when opening them.

6. Outlet valves which have become clogged with ice should be thawed with warm water. Do not use scalding water or an open flame.

7. Be sure the regulator tension screw is released before opening the cylinder valve. Always open the valve slowly to avoid strain on the regulator gauge which records the cylinder pressure. Do not open the valves more than one and one-half turns. Usually one half turn is sufficient. Always use the special T-wrench provided for the acetylene cylinder valve. Leave this wrench on the stem of the valve while the cylinder is in use so that the acetylene can be quickly turned off in an emergency.

8. Acetylene is a highly combustible fuel gas and great care should be taken to keep sparks, flames, and heat away from the cylinders. Never open an acetylene cylinder valve near other welding or cutting work.

9. Never test for an acetylene leak with an open flame. Test all joints with soapy water. Should a leak occur around the valve stem of the cylinder, close the valve and tighten the packing nut. Cylinders leaking around the safety fuse plug should be taken outdoors, away from all fires and sparks, and the valve opened slightly to permit the contents to escape.

10. If an acetylene cylinder should catch fire it usually can be extinguished with a wet blanket. A burlap bag wet with a calcium chloride solution is effective for such an emergency. If these fail, spray a stream of water on the cylinder to keep it cool.

11. Never interchange acetylene regulators, hose, or other apparatus with similar equipment intended for oxygen.

12. Always turn the acetylene cylinder so that the valve outlet will point away from the oxygen cylinder.

13. When returning empty cylinders, see that the valves are closed to prevent escape of residual acetylene or acetone solvent. Screw on protecting caps.

14. SPECIAL CAUTION: Never use oxy-gas equipment in a confined space without adequate ventilation.
REMEMBER: Oxygen will saturate clothing and it takes only one small spark to cause a fatal accident.

Oxygen Cylinders

1. Always refer to oxygen by its full name and not by the word "air" alone.

2. Keep oxygen away from oil, grease, and other flammable materials. Do not handle oxygen cylinders, valves, regulators, hose or apparatus with oily hands. Do not permit a jet of oxygen to strike greasy clothes, any oily surface, or to enter a fuel oil storage container.
(Warning: Oil or grease in the presence of oxygen will ignite violently, especially in an enclosed pressurized area.)

3. Do not store oxygen cylinders together with cylinders containing acetylene or other fuel gases. They should be grouped separately, and if possible, with a fire resisting wall between the acetylene and oxygen cylinders.

4. When oxygen cylinders are in use or being moved, care must be taken to avoid dropping, knocking over, or striking the cylinders with heavy objects. Do not handle oxygen cylinders roughly.

5. All oxygen cylinders with leaky valves or safety fuse plugs should be set aside and marked for the attention of the supplier. Do not tamper with or attempt to repair oxygen cylinder valves. Do not use a hammer or wrench to open the valves.
(Warning: Do not substitute oxygen for compressed air in pneumatic tools. Do not use it to blow out pipe lines, test radiators, purge tanks or containers, or "dust" clothing or work.)

6. Open the oxygen cylinder valve slowly to prevent damage to the regulator high pressure gauge mechanism. Be sure that the regulator tension screw is released before opening the valve. When not in use the cylinder valves should be closed, and the protecting caps screwed on to prevent damage to the valves.

7. When the oxygen cylinder is in use, open the valves to the full limit. This will prevent leakage around the valve stem.

8. Always use regulators on oxygen cylinders in order to reduce the cylinder pressure to a low working pressure. Otherwise the high pressure will burst the hose.

9. Never interchange oxygen regulators, hose, or other apparatus with similar equipment intended for other gases.

Hose

1. Do not allow the hose to come in contact with oil or grease. These will penetrate and deteriorate the rubber, constituting a hazard with oxygen.

2. Always protect the hose from being walked on or run over. Avoid kinks and tangles. Do not leave the hose where anyone can trip over it. This could result in personal injury, damaged connections, or cylinders being knocked over. Do not work with the hose over your shoulder, around your legs, or tied to your waist.

3. Protect the hose from hot slag, flying sparks, and open flame.

4. Never force hose connections which do not fit. Do not use white lead, oil, grease, or other pipe fitting compounds for connections on hose, torch or other equipment. Never crimp hose to shut off gases.

5. Examine all hoses periodically for leaks by immersing hose in water while under pressure. Do not use matches to check for leaks in the acetylene hose. Repair leaks by cutting hose and inserting a splice. Do not use tape for mending. Replace hose if necessary.

6. Make sure that the hose is attached securely to torches and regulators before using.

7. Do not use new or stored hose lengths without first blowing them out with compressed air to eliminate talc or accumulated foreign matter which might otherwise enter and clog the torch parts.

8. Do not tape oxygen and acetylene hoses together.

SAFETY PRECAUTIONS IN WELDING OPERATIONS

Section II

Safety Precautions for Arc Welding

Electric Circuits

1. The AC and DC open circuit voltages are low compared to voltages used for lighting circuits and motor driven shop tools. Normally they cause neither injury nor shock; however, these voltages can cause severe shock, particularly in hot weather, when the welder is sweating. Consequently, the precautions listed below should always be observed:

   A. Check the welding equipment to make certain that electrode connections and insulation on holders and cables are in good condition;

   B. Keep hands and body insulated from both the work and the metal electrode holder. Avoid standing on wet floors or coming in contact with grounded surfaces; and,

   C. Perform all welding operations within the rated capacity of the welding cables. Excessive heating will impair the insulation and damage the cable leads.

2. Inspect the cables periodically for looseness at the joints, defects due to wear, or other damage. Defective or loose cables are a fire hazard. Defective electrode holders should be replaced and connections to the holder should be tightened.

3. Welding generators should be located or shielded so that dust, water or other foreign matter will not enter the electrical windings or the bearings.

Welding Machines

1. When electric generators powered by internal combustion engines are used inside buildings or in confined areas, the engine exhaust must be conducted to the outside atmosphere.

2. Check welding equipment to make sure that the electrode connections and the insulation on holders and cables are in good condition. All checking should be done on dead circuits. All serious trouble should be investigated by a trained electrician.

3. A motor-generator type of arc welding machine must have a power ground on the machine. Without this, stray current may cause a severe shock to the operator if contact is made with the machine and a good ground.

4. Do not operate the polarity switch while the machine is operating under welding current load. Consequent arcing at the switch will damage the contact surfaces, and the flash may burn the person operating the switch.

5. Do not operate the rotary switch for current setting while the machine is operating under the welding current load; severe burning of the switch contact surfaces will result. Operate the rotary switch while the machine is idling.

6. Disconnect the welding machines from the power supply when they are left unattended.

7. Use well insulated electrode holders and cables. Wear dry, protective covering on hands and body.

8. Partially-used electrodes should be removed from the holders when not in use. A place should be provided to hang up or lay down the holder so that it will not come in contact with persons or conducting objects.

9. The work clamp must be attached securely to the work before the welding operation is started.

Protective Screens

1. When welding is done near other personnel, screens should be used to protect their eyes from the arc or reflected glare.

2. Portable screens should be used to prevent drafts of air from interfering with the stability of the arc.

SAFETY PRECAUTIONS IN WELDING OPERATIONS

Section III

Safety Precautions for Gas-shielded Arc Welding

Potential Hazards

Gas-shielded arc welding processes have certain dangers associated with them. The following are hazards which are peculiar to or might be increased by gas-shielded arc welding;

1. Gases
   A. Ozone
   B. Oxides of nitrogen
   C. Carbon dioxide and carbon monoxide
   D. Trichloroethylene and perchloroethylene decomposition

2. Radiant energy

3. Radio activity from thoriated tungsten electrodes

4. Metal fumes

Protective Measures

1. Gases

   A. Ozone concentration increases with the type of electrodes used, amperage, extension of arc time, and increased argon flow. If welding is carried out in confined spaces the ozone concentration may increase to harmful levels. Under conditions of good ventilation and good welding practices, ozone will not be a hazard.

   B. In most wleding operations, natural ventilation is sufficient to reduce the danger of nitrogen dioxide to a safe level; however, during gas tungsten arc cutting of stainless steel, using a 90 percent nitrogen-10 percent argon mixture as the shielding gas, nitrogen oxide concentrations are very high. High concentrations also have been found during experimental use of nitrogen as a shield gas. The amount of nitrogen oxides produced constitutes a definite health hazard, and ventilation should be provided for their control.

   C. Carbon dioxide is disassociated by the heat of the arc to form carbon monoxide. Under normal welding conditions in open air or in large work areas there should be no hazard from inhalation of these gases; however, where the welder works with the head directly in the path of the fumes, or where welding is done in a confined space, ventilation adequate to control the fumes should be provided.

   D. Eye, nose, and throat irritation can be produced when welding is carried on near a source of trichloroethylene or perchloroethylene vapors. Two sources of these vapors are wiping rags and degreasers. Ultraviolet radiation from the arc causes rapid decomposition of these vapors which are in the vicinity. Welding in an area with

D. these vapors can produce dangerously high concentrations of noxious fumes, including phosgene, This decomposition is accompanied by a very irritating, disagreeable odor.

2. Radiant Energy

The total radiant energy produced by the gas-shielded arc is approximately twice as great as that produced by the shielded metal-arc at equal current values. Visible light is increased with gas-shielded arc welding, so the deepest shade of filter glass that permits adequate visibility should be used by the welder. Leather, wool, and aluminum coated cloth withstand the action of radiant energy reasonably well; however, aluminum coated cloth may present reflection and conductivity hazards. Cotton clothing will disintegrate in from one day to two weeks because of ultraviolet radiation. Skin burns will occur following a short exposure.

3. Radioactivity from Thoriated-Tungsten Electrodes

Gas tungsten-arc welding using these electrodes may be employed with no significant hazard to the welder or other room occupants. Special ventilation or protective equipment is not indicated for protection from radioactive fumes, except possibly in a small totally enclosed space.

4. Metal Fumes

A large number of metals may be welded using the gas-shielded arc process. The physiological effects, if any, of the fumes produced will vary with the metal involved. Normal ventilation and protection requirements should be adequate to prevent metal fume concentration.

SHOP MANAGEMENT
Welding I-II
(Example)

In order to create an atmosphere where high school and adult students may learn good work habits and acquire the ability to accept supervision, the welding shop will be organized so that students may participate, on a rotating basis, in assignments that could be of value should the student be employed or appointed in these positions (all assignments shall be made for a given period of time by the instructor who is responsible for conducting the activities.)

The jobs listed below will afford the students the opportunity to participate in all phases of shop operation:

1. Shop supervisor
2. Records clerk
3. Maintenance supervisor
4. Safety supervisor
5. Safety committee (2 students)
6. Outside work committee (3 students)
7. Energy conservation supervisor
8. Tool supervisor

Following is a list of duties for each assignment:

1. Shop supervisor

    a. Calls classes to order
    b. Assigns tables and machines
    c. Inspects shop during work period
    d. Conducts clean up
    e. Signals students to buses
    f. Makes all work orders

2. Records clerk

    a. Calls roll
    b. Updates progress charts
    c. Issues and orders supplies
    d. Checks delivery of gases
    e. Assists in the grading of test
    f. Records results of bend testing for certification purposes

3. Maintenance supervisor

   a. Conducts machine repair
   b. Inspects machines daily
   c. Inspects cables clamps (weekly)
   d. Conducts machine cleaning each 90 days
   e. Fills in when shop supervisor is absent

4. Safety supervisor

   a. Conducts daily safety inspection of machines
   b. Conducts and records weekly inspection of all electrical equipment
   c. Records all safety violations observed during work period
   d. Presides over all safety committee meetings
   e. Assumes duties of shop or maintenance supervisor during their absences

5. Safety committee

   a. Investigates accidents
   b. Prepares accident reports
   c. Hears and decides disposition of all serious safety violations

6. Outside work committee

   a. Reviews and evaluates all live work for educational value
   b. Assigns outside work to students where students may benefit from such work
   c. Evaluates students progress on assignments
   d. Advises instructor when live work hinders training progress

7. Energy conservation supervisor

   a. Checks and turns off all unnecessary lighting during work period
   b. Insure that all machines are shut down during breaks
   c. Checks to see hot water spigots are not left on
   d. Makes sure all windows and doors are closed when overhead heaters are operating
   e. Checks to insure that gases are not being wasted

8. Tool supervisor

   a. Inspects tools for serviceability
   b. Assists the instructor in ordering tools
   c. Reports all tool abuses to instructor
   d. Insures that all tools are cleaned and returned to storage area at end of period
   e. Recommends small tools that might be purchased to enhance training
   f. Conducts tool inventory every 30 days